ACC.13
62nd Annual Scientific Session & Expo
TCT@ACC-i2

E1091
JACC March 12, 2013
Volume 61, Issue 10

Imaging

A COMPARISON OF THREE ECHOCARDIOGRAPHIC METHODS FOR CALCULATING STROKE VOLUME

Poster Contributions
Poster Sessions, Expo North
Monday, March 11, 2013, 9:45 a.m.-10:30 a.m.

Session Title: Imaging: CRT/New Technology
Abstract Category: 18. Imaging: Echo
Presentation Number: 1312-337

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Background: Two-dimensional Doppler echocardiography calculates left ventricular stroke volume from the product of the left ventricular outflow tract (LVOT) area and the velocity time integral obtained by pulse Doppler. Two-dimensional methods assume that the outflow tract area is circular when in fact it is elliptical. Three-dimensional echocardiography need not rely on this assumption and so may be more accurate. The purpose of this study was to compare the accuracy of two-dimensional with three-dimensional techniques for the measurement of stroke volume.

Methods: Thermodilution stroke volume (TDSV) was the standard against which three echocardiographic methods were compared: 1. Two-dimensional echocardiography with a circular LVOT area (2DSV), 2. Three-dimensional echocardiography with a planimetered LVOT area (PLANSV) and 3. Three-dimensional echocardiography derived from left ventricular volume measurements (VOLSV). Adult patients referred for right heart catheterization were consented for the study.

Results: The study population consisted of 10 females and 14 males with a mean age of 60 +/- 8 years and body surface area of 2.0 +/- 0.4 square meters. Repeated measures analysis of variance indicated that 2DSV and VOLSV underestimated TDSV with average differences and 95% confidence intervals of -21 +/- 10 and -24 +/- 10 milliliters respectively ($p<0.05$), whereas PLANSV accurately predicted TDSV with an average difference and 95% confidence interval of -1 +/- 10 milliliters ($p>0.05$). Bland-Altman plots showed that 2DSV and VOLSV underestimated TDSV with wide limits of agreement. The average difference and 95% limits of agreement were -21 (-54 to 13) and -23 (-84 to 38) milliliters for 2DSV and VOLSV respectively. However, Bland-Altman plot for PLANSV showed no systematic bias with an average difference and 95% limits of agreement of -1 (-41 to 40) milliliters.

Conclusions: Three-dimensional echocardiography with planimetry of the LVOT was the only accurate technique for measurement of stroke volume. Two-dimensional and volumetric three-dimensional echocardiography techniques were inaccurate due to both underestimation and wide ranges of agreement.